local government and Native American tribal consultations, environmental and engineering analyses, and National Environmental Policy Act reviews.

DOE has identified mostly rail as its preferred mode of transportation, both nationally and in the State of Nevada. At this time, the Department has not identified a preference for a specific rail corridor in Nevada. If the Yucca Mountain site was recommended and approved, DOE would identify such a preference in consultation with affected stakeholders, particularly the State of Nevada. In this case, DOE would announce its preferred corridor in a *Federal Register* notice, and would publish its decision to select a corridor in a Record of Decision no sooner than 30 days after the announcement of a preference.

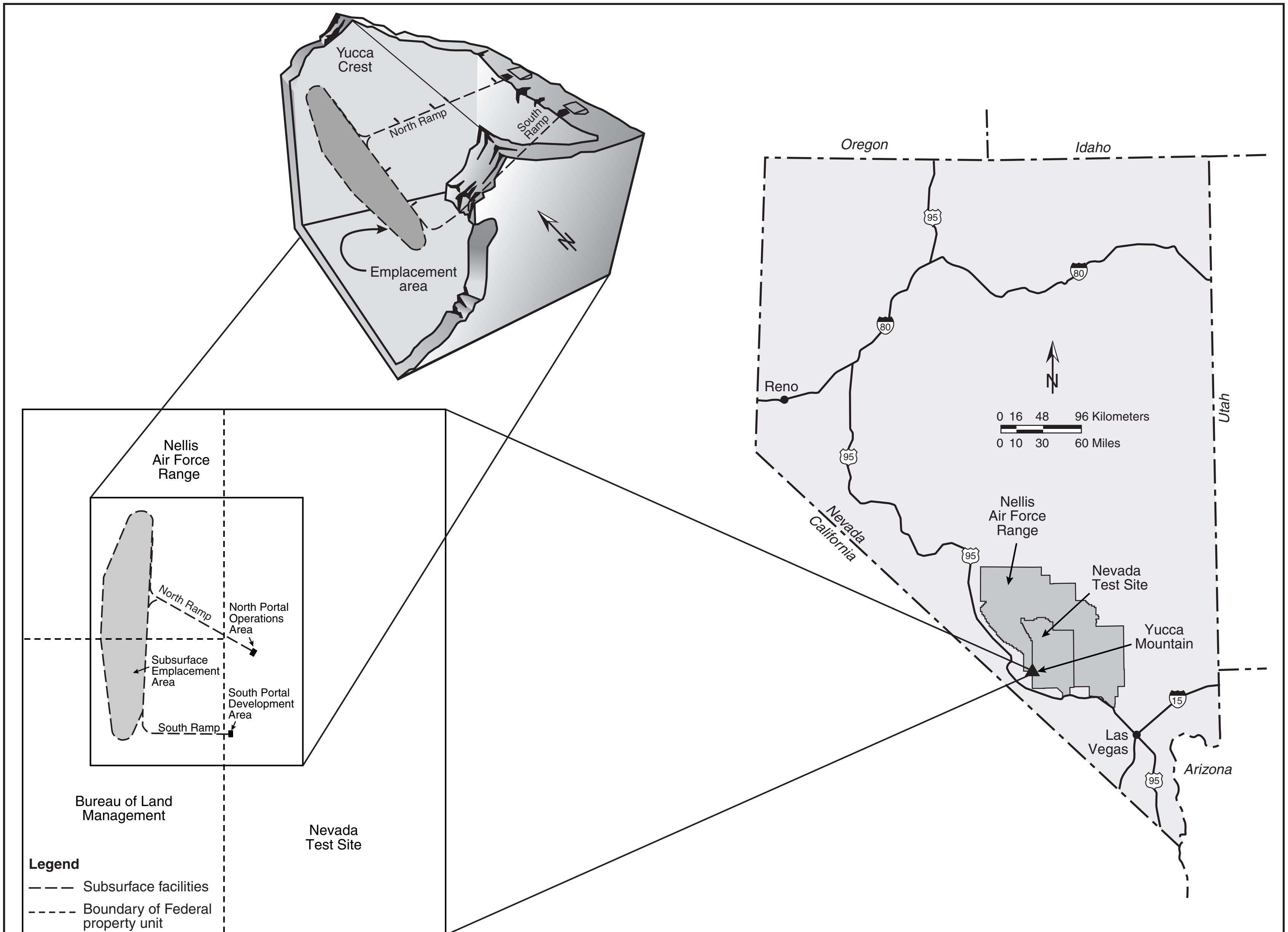
2.1 Proposed Action

DOE proposes to construct, operate and monitor, and eventually close a geologic repository at Yucca Mountain for the disposal of spent nuclear fuel and high-level radioactive waste. In its simplest terms, the proposed repository would be a large underground excavation with a network of *drifts* (tunnels) that DOE would use for spent nuclear fuel and high-level radioactive waste emplacement. About 600 square kilometers (230 square miles or 150,000 acres) of land in Nye County, Nevada, could be permanently withdrawn from public access for repository use. The proposed location of the repository is shown in Figure 2-2. DOE would dispose of spent nuclear fuel and high-level radioactive waste in the repository using the inherent, natural geologic features of the mountain and engineered (manmade) barriers to help ensure the long-term isolation of the spent nuclear fuel and high-level radioactive waste from the human environment. DOE would build the repository emplacement drifts inside Yucca Mountain at least 200 meters (660 feet) below the surface and at least 160 meters (530 feet) above the present-day *water table* (DIRS 154554-BSC 2001, pp. 28 and 29).

Under the Proposed Action, DOE would permanently place approximately 11,000 (DIRS 152010-CRWMS M&O 2000, p. 14) to 17,000 waste packages containing no more than 70,000 metric tons of heavy metal (MTHM) of spent nuclear fuel and high-level radioactive waste in a repository at Yucca Mountain. Of the 70,000 MTHM to be emplaced in the repository, 63,000 MTHM would be spent nuclear fuel assemblies from boiling-water and *pressurized-water reactors* (Figure 2-3) that DOE would ship from commercial nuclear sites to the repository. The remaining 7,000 MTHM would consist of about 2,333 MTHM of DOE spent nuclear fuel and 8,315 canisters (4,667 MTHM) containing solidified high-level radioactive waste (see Figure 2-3) that the Department would ship to the repository from its facilities. The 70,000-MTHM inventory would include surplus weapons-usable plutonium as spent mixed-oxide fuel or immobilized plutonium. Appendix A contains additional information on the inventory and characteristics of spent nuclear fuel, high-level radioactive waste, and other materials that DOE could emplace in the proposed repository. For this EIS, a connected action includes the offsite manufacturing of the containers that DOE would use for the transport and disposal of spent nuclear fuel and high-level radioactive waste and the specialized titanium drip shields and corrosion-resistant emplacement pallets that DOE could install over and under, respectively, the waste packages to improve performance and to reduce *uncertainty* about the long-term performance of the repository.

DEFINITION OF METRIC TONS OF HEAVY METAL

Quantities of spent nuclear fuel are traditionally expressed in terms of *metric tons of heavy metal* (typically uranium), without the inclusion of other materials such as cladding (the tubes containing the fuel) and structural materials. A metric ton is 1,000 kilograms (1.1 tons or 2,200 pounds). Uranium and other metals in spent nuclear fuel (such as thorium and plutonium) are called *heavy metals* because they are extremely dense; that is, they have high weights per unit volume. One metric ton of heavy metal disposed of as spent nuclear fuel would fill a space approximately the size of a typical household refrigerator.



Source: Modified from DIRS 104508-CRWMS M&O (1999, Attachment IV, Figure 1).

Figure 2-2. Diagram and location of the proposed repository at Yucca Mountain.

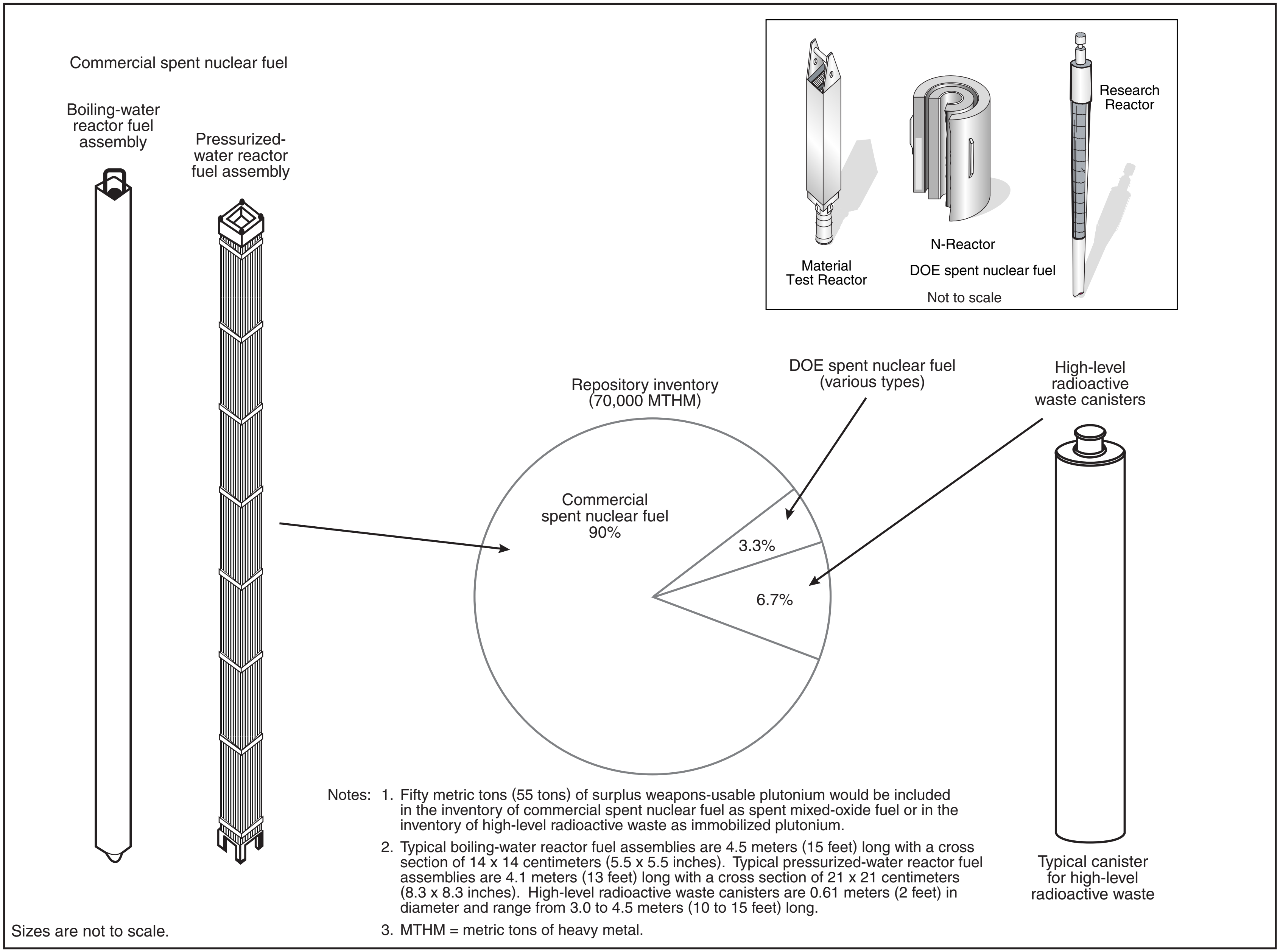


Figure 2-3. Sources of spent nuclear fuel and high-level radioactive waste proposed for disposal at the Yucca Mountain Repository.

Figure 2-4 is an overview of components or activities associated with the Proposed Action. The implementing alternatives and scenarios analyzed in this EIS, as described in Section 2.1.1, represent the potential range of variables associated with implementing the Proposed Action that could affect environmental impacts. The Proposed Action would require surface and subsurface facilities and operations for the receipt, packaging, possible surface *aging*, and emplacement of spent nuclear fuel and high-level radioactive waste (see Section 2.1.2) and transportation of these materials to the repository (see Section 2.1.3). Section 2.1.5 summarizes the estimated cost of the Proposed Action. Chapters 4, 5, and 6 evaluate potential environmental impacts from the Proposed Action. As part of the process to develop implementing concepts, mitigation techniques have been designed into the Proposed Action through the use of best engineering and management practices, as applicable.

The Proposed Action would use two types of institutional controls—active and passive. Active institutional controls (monitored and enforced limitations on site access; inspection and *maintenance* of waste packages, facilities, equipment, etc.) would be used through closure. Passive institutional controls (markers, engineered barriers, etc., that are not monitored or maintained) would be put in place during closure and used to minimize inadvertent exposures to members of the public in the future.

2.1.1 OVERVIEW OF IMPLEMENTING ALTERNATIVES AND SCENARIOS

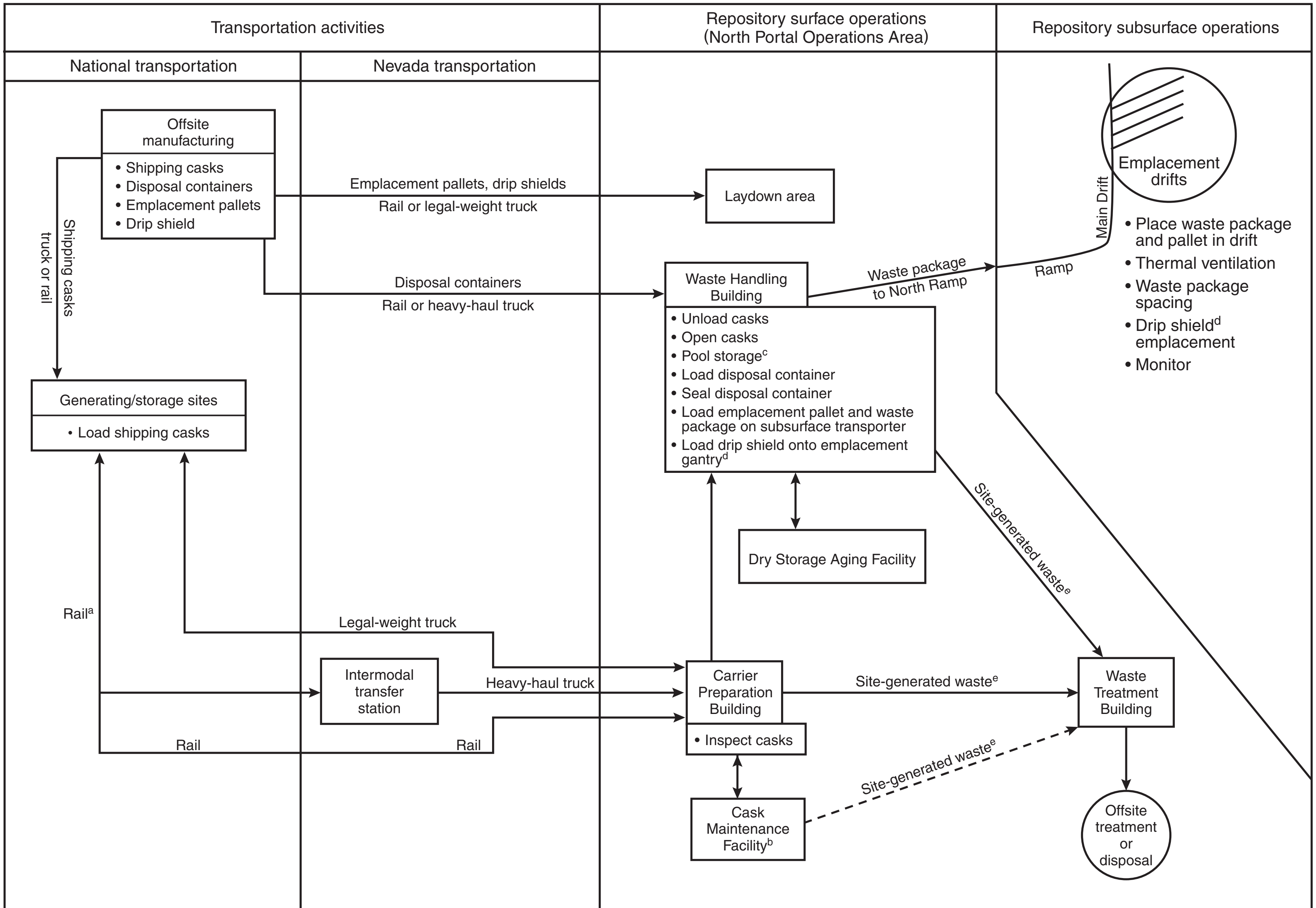
This EIS describes and evaluates the current preliminary design concept for repository surface facilities, subsurface facilities, and disposal containers (waste packages), and the current plans for the construction, operation and monitoring, and closure of the repository. DOE recognizes that plans for the repository would continue to evolve during the development of the final repository design and as a result of the U.S. Nuclear Regulatory Commission licensing review of the repository. While the design continues to evolve, it is based on decades of similar experience in mining operations and the management of spent nuclear fuel and other radioactive materials, as well as the ongoing site characterization and *performance confirmation* activities and results. In addition, decisions on how spent nuclear fuel and high-level radioactive waste would be shipped to the repository (for example, truck or rail) and how spent nuclear fuel would be packaged (*uncanistered* or in disposable or dual-purpose canisters) would be part of future transportation planning efforts.

DISPOSAL CONTAINERS AND WASTE PACKAGES

A *disposal container* is the vessel consisting of the barrier materials and internal components in which the spent nuclear fuel and high-level radioactive waste would be placed. The filled, sealed, and tested disposal container is referred to as the *waste package*, which would be emplaced in the repository.

For these reasons, DOE developed implementing alternatives and analytical scenarios to bound the environmental impacts likely to result from the Proposed Action in the EIS (see Figure 2-5). The Department selected the implementing alternatives and scenarios to accommodate and maintain flexibility for potential future revisions to the design and operation of the repository. Because of uncertainties, DOE selected implementing alternatives and scenarios that incorporate conservative assumptions that tend to overstate the risks to address those uncertainties.

The following paragraphs describe the packaging scenarios, repository operating modes, national transportation scenarios, Nevada transportation scenarios, and implementing rail and intermodal alternatives evaluated in the EIS.



a. Heavy-haul trucks or barges could be used to deliver spent nuclear fuel from generating/storage sites that did not have rail access to a nearby rail line.

b. For the EIS analysis, assumed to be at the repository.

c. Possible aging of commercial fuel for lower-temperature operating mode.

d. Drip shields emplaced during repository closure.

e. Or directly to offsite treatment or disposal.

Figure 2-4. Overview flowchart of the Proposed Action.

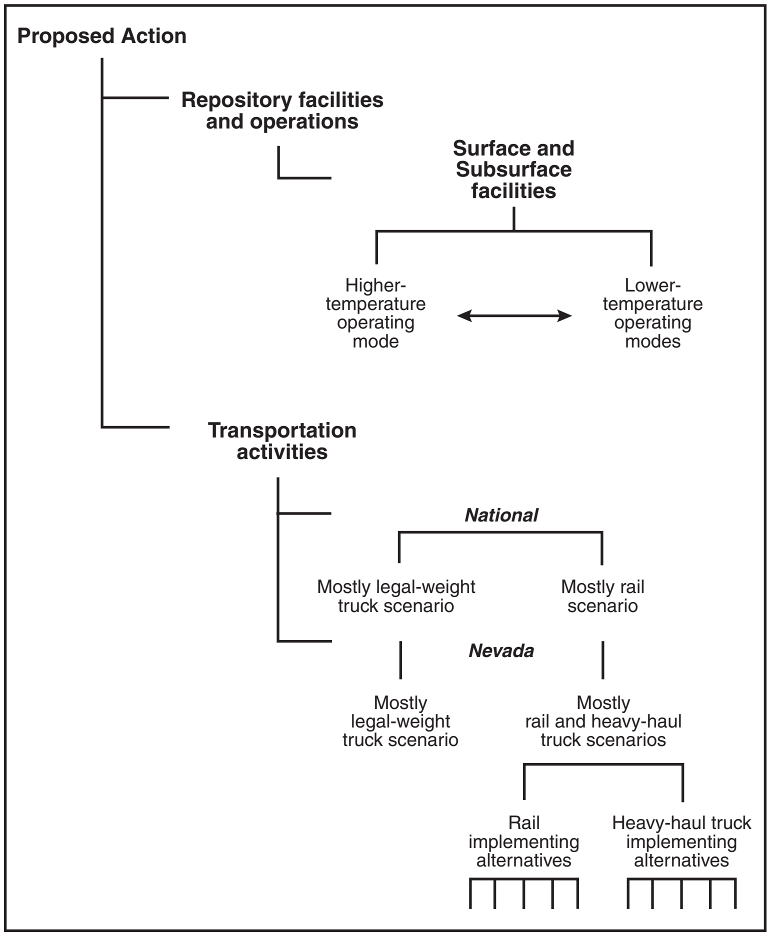


Figure 2-5. Analytical scenarios and implementing alternatives associated with the Proposed Action.

2.1.1.1 Packaging Scenarios

DOE operations at repository surface facilities would differ depending on how the spent nuclear fuel in shipping casks was packaged. Commercial spent nuclear fuel could be received either uncanistered or in disposable or dual-purpose canisters.

The EIS assumes that DOE spent nuclear fuel and high-level radioactive waste would be shipped to the repository in *disposable canisters*. In addition, it evaluates the following packaging scenarios for commercial spent nuclear fuel to cover the potential range of environmental impacts from repository surface facility construction and operation:

- A mostly uncanistered fuel scenario
- A mostly canistered fuel scenario

For this Final EIS, DOE simplified the presentation of the packaging scenarios that were analyzed in the Draft EIS by analyzing only one bounding packaging scenario (the Draft EIS considered both mostly canistered and uncanistered scenarios). DOE was able to simplify the presentation of impacts in the Final EIS because the Draft EIS analysis demonstrated that the mostly uncanistered fuel packaging scenario bounded the analysis in all cases with the exception of (1) the empty dual-purpose canisters that some commercial sites could use that would require disposal or recycling, and (2) some attributes of offsite manufacturing of the disposable canister. The presentation of potential impacts in Chapter 4 of this Final

DEFINITIONS OF PACKAGING TERMS

Shipping cask: A vessel that meets applicable regulatory requirements for shipping spent nuclear fuel or high-level radioactive waste.

Dual-purpose canister: A metal vessel suitable for storing (in a storage facility) and shipping (in a shipping cask) commercial spent nuclear fuel assemblies. At the repository, dual-purpose canisters would be removed from the shipping cask and opened. The spent nuclear fuel assemblies would be removed from the canister and placed in a disposal container or in the fuel pool to accommodate blending. The opened canister would be recycled or disposed of offsite as low-level radioactive waste.

Disposable canister: A metal vessel for commercial or DOE spent nuclear fuel assemblies or solidified high-level radioactive waste suitable for storage, shipping, and disposal. At the repository, the disposable canister would be removed from the shipping cask and placed directly in a disposal container. The disposable canister is sometimes referred to as a multi-purpose canister in discussions of repository design.

Uncanistered spent nuclear fuel: Commercial spent nuclear fuel placed directly into shipping casks. At the repository, spent nuclear fuel assemblies would be removed from the shipping cask and placed in a disposal container or in the fuel pool to accommodate blending.

Disposal container: A container for spent nuclear fuel and high-level radioactive waste consisting of the barrier materials and internal components. The filled, sealed, and tested disposal container is referred to as the *waste package*, which would be emplaced in the repository.

Waste package: The filled, sealed, and tested disposal container that would be emplaced in the repository.

EIS primarily reports impacts associated with the mostly uncanistered scenario. Where the canistered scenario would result in greater impacts (that is, waste management and offsite manufacturing impacts), the greater impacts are provided. Therefore, the scenarios discussed in this Final EIS represent current design concepts and bound the impacts of any canister scenario, including the disposable canister scenario. DOE ultimately might select either scenario. For all scenarios, high-level radioactive waste and DOE spent nuclear fuel remain in the disposable canisters in which they were received for emplacement.

Table 2-1 summarizes these scenarios.

Table 2-1. Packaging scenarios (percentage based on number of shipments).

Material[a]	Mostly uncanistered fuel	Mostly canistered fuel
Commercial SNF	100% uncanistered fuel	About 80% dual-purpose canisters; about 20% uncanistered fuel
HLW	100% disposable canisters	100% disposable canisters
DOE SNF	100% disposable canisters	100% disposable canisters

a. SNF = spent nuclear fuel; HLW = high-level radioactive waste.

2.1.1.2 Repository Operating Modes

The heat generated by spent nuclear fuel and high-level radioactive waste could affect the long-term performance of the repository (that is, the ability of the engineered and natural barrier systems to isolate the emplaced waste from the human environment). Different repository operating modes would have a direct effect on internal and external waste package temperatures, thereby potentially affecting the corrosion rate and integrity of the waste packages.

Parameters associated with maximum repository temperatures (see Table 2-2) are central to defining the operating modes of the flexible design. The repository temperature would depend on factors related to the design and operation of the repository including, but not limited to, the age and *burnup* of the spent nuclear fuel at the time of emplacement, the spacing of the emplacement drifts and the waste packages in them, and the repository ventilation method and duration. The implementation of these design and operational parameters would affect the short-term environmental impacts of the repository.

Table 2-2. Summary of key underground design and operating parameters associated with repository operating modes analyzed in the EIS.

Parameter	Unit of measure	Repository operating mode: Higher-temperature[a]	Repository operating mode: Lower-temperature[b]
Linear thermal load	Kilowatts per meter	1.42	0.65 to 1[c]
Drift spacing	Meters[d]	81	81[e]
Areal mass load	MTHM[f] per acre	56	25 to 39
Waste package spacing	Meters	0.1	0.1 to 6.4[e]
Emplacement duration	Years	24	24 (50)[g]
Preclosure ventilation duration[h]	Years	100	149 to 324
Closure duration	Years	10	11 to 17
Ventilation rate (forced)	Cubic meters[i] per second in drift	15	15
External ventilation shafts (emplacement and development)	Number	7	9 to 17
Dependent parameter			
Underground area	Square kilometers	4.7	6.5 to 10.1
Total excavated repository volume[j]	Millions of cubic meters	4.4	5.7 to 8.8
Waste packages	Number (in thousands)	11 to 12	11 to 17

a. Source: DIRS 150941-CRWMS M&O (2000, all).
b. Sources: DIRS 152003-McKenzie (2000, all); DIRS 153849-DOE (2001, all).
c. If commercial SNF is aged, linear thermal loads will be lower.
d. To convert meters to feet, multiply by 3.2808.
e. Drift spacing and waste package spacing determine various areal mass loads.
f. MTHM = metric tons of heavy metal.
g. The lower-temperature repository operating mode analysis assumed that waste emplacement with commercial spent nuclear fuel aging would occur over a 50-year period for scenarios that used aging at the repository.
h. From start of emplacement to start of repository closure.
i. To convert cubic meters to cubic feet, multiply by 35.314.
j. Includes existing Exploratory Studies Facility volume of 420,000 cubic meters (15 million cubic feet).

The basis for the three thermal load scenarios in the Draft EIS was the amount of commercial spent nuclear fuel that DOE would emplace per unit area of the repository (areal mass loading). These scenarios included a relatively high emplacement density of commercial spent nuclear fuel (high thermal load – 85 MTHM per acre), a relatively low emplacement density (low thermal load – 25 MTHM per acre), and an emplacement density between the high and low thermal loads (intermediate thermal load – 60 MTHM per acre).

Rather than focusing on thermal loads, the flexible design focuses on controlling the temperature of the rock between the drifts, and on the surface of the waste package and drift walls. The flexible design uses a *linear thermal load* (heat output per unit length of the emplacement drift) and emplaces waste packages closer together than the Draft EIS design. Linear thermal load is expressed in terms of kilowatts per meter.

The design discussed in the *Yucca Mountain Science and Engineering Report: Technical Information Supporting Site Recommendation Consideration* (DIRS 153849-DOE 2001, all) includes the ability to operate the repository in a range of modes that address higher and lower temperatures. *Higher-temperature* means that at least a portion of the emplacement drift rock wall would have a maximum temperature above the boiling point of water at the elevation of the repository [96°C (205°F)]. The *lower-temperature* operating mode ranges include conditions under which the drift rock wall temperatures would be below the boiling point of water, and conditions under which waste package surface temperatures would not exceed 85°C (185°F).

To construct the analytical basis for evaluation of repository impacts, DOE used widely accepted analytical tools, coupled with the best available information, and cautious but reasonable assumptions where uncertainties exist, to estimate potential environmental impacts. This included applying conservative assumptions to the set of reasonable operating scenarios identified in the Science and Engineering Report (DIRS 153849-DOE 2001, p. 2-24) to ensure that the EIS did not underestimate potential environmental impacts and to accommodate the greatest range of potential future actions.

DOE has established parameters for the range of potential repository operating modes and has identified these parameters and their ranges in Table 2-2. These operating modes provide the basis for evaluation of the environmental impacts described in Chapter 4. The key to ensuring that the range of potential impacts evaluated fully encompasses the impacts that could occur under any reasonable repository mode of operation requires a basic understanding of how the particular impacts relate to the various parameters, particularly those parameters that could be varied to achieve lower-temperature operation.

As shown in the Draft EIS and the Supplement to the Draft EIS, the short-term impacts (preclosure) would increase with the size of the repository emplacement area and surface facilities. The smallest repository and surface facilities are associated with the higher-temperature repository operating mode and therefore would result in the lowest short-term environmental impacts. As detailed in Section 2.1.1.2.2, the lower-temperature repository operating mode would be achieved by varying several of the design parameters independently or in combination, for differing effects. Design parameters include waste package loading, repository ventilation duration, and waste package spacing. In the analyses, DOE maximized each of these parameters in turn, and assumed reasonably conservative values for the other dependent parameters to evaluate the full range of potential environmental impacts. As an example, DOE considered a repository with the largest waste package spacing (6.4 meters), with and without the use of surface aging. The result was the largest repository emplacement area and surface facilities and therefore the highest potential impacts for some *environmental resource areas* (for example, land disturbance, nonradiological air quality, and water use). Conversely, when DOE assumed the long postemplacement ventilation period (up to 300 years), with and without the surface aging facility, the result was a repository that would be open for a longer period with higher potential for impacts to workers and release of naturally occurring radon from the open repository to the offsite public. DOE evaluated the reasonable combinations of these variable design parameters to establish the range of impacts reported in Chapter 4 and summarized in Section 2.4.

2.1.1.2.1 *Higher-Temperature Repository Operating Mode*

The higher-temperature repository operating mode would ensure that a portion of the rock between the drifts would have maximum temperatures below the boiling point of water [96°C (205°F)] (DIRS 153849-DOE 2001, Section 2.1.2) at the elevation of the emplacement horizon (see Figure 2-6). This would allow any water mobilized by the higher-temperature conditions in the drifts to drain between the drifts. The development of a localized boiling region around each emplacement drift, rather than a single boiling region encompassing all the emplacement drifts, would ensure that very little water would be able to accumulate above any emplacement drift. This would substantially decrease the likelihood of water penetrating the emplacement drifts by means of fast paths such as fractures. The higher-temperature operating mode is based on this heat management criterion to keep boiling temperatures from spreading

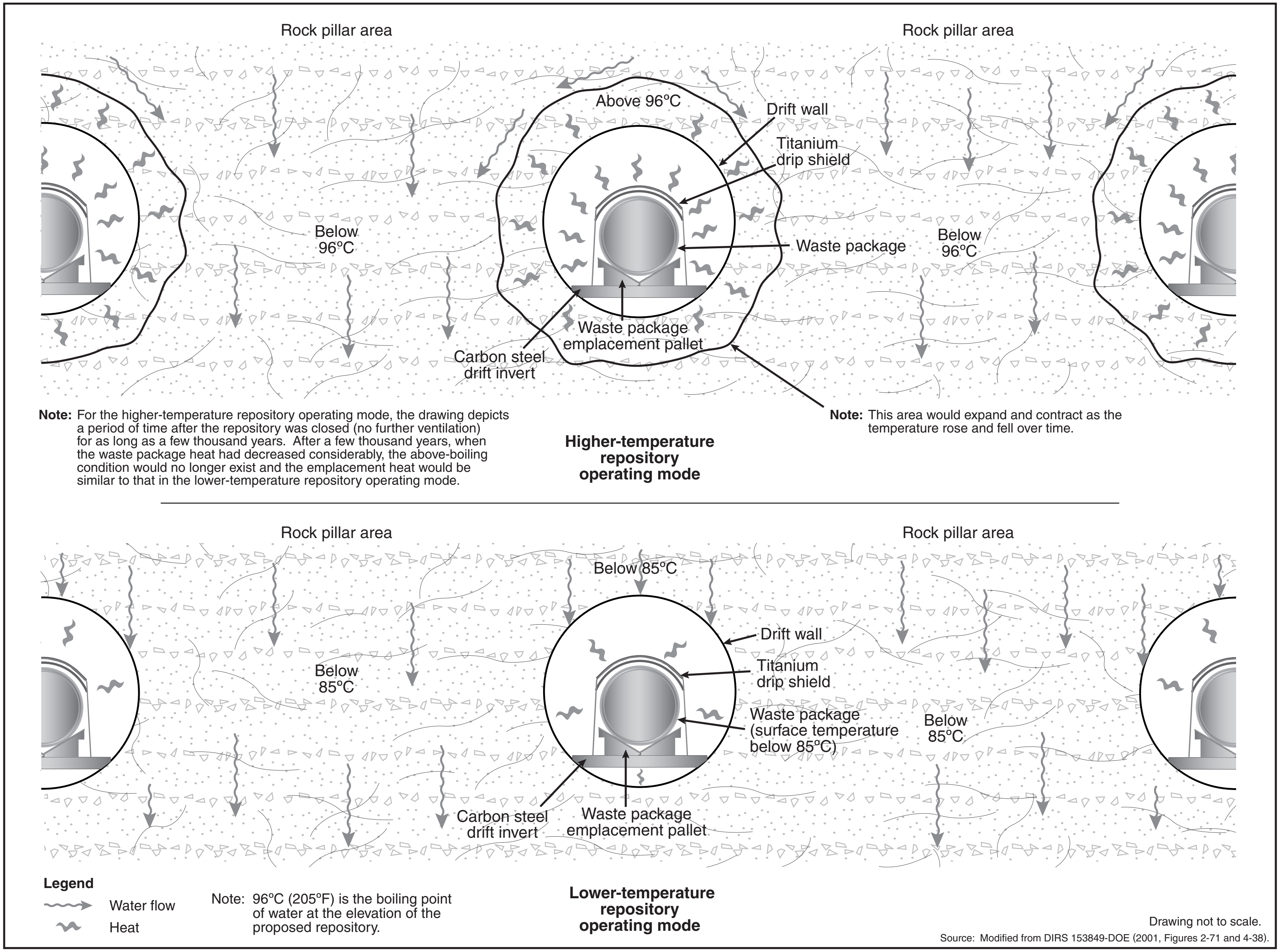


Figure 2-6. Artist's conception of water flow around emplacements for higher- and lower-temperature repository operating modes.

all the way through the rock between drifts after closure, while allowing repository closure as early as 50 years after the start of emplacement.

2.1.1.2.2 *Lower-Temperature Repository Operating Mode*

DOE could operate the repository in a lower-temperature mode by varying certain operational parameters. The lower-temperature operating mode range includes conditions under which the drift rock wall temperatures would be below the boiling point of water [96ºC (205ºF)] at the elevation of the repository, as well as conditions under which waste package average surface temperatures would not exceed 85ºC (185ºF) (see Figure 2-6).

DOE is considering the lower-temperature operating mode to reduce some of the uncertainties associated with assessing long-term repository performance. Lower temperatures might have less effect on rock properties and geochemistry, thereby reducing the complexities in modeling thermal effects. This, in turn, could reduce uncertainties in assessments of future repository performance. Lower in-drift temperatures could also reduce the potential for waste package corrosion.

The primary variables governing a lower waste package surface temperature and the thermal response of the surrounding rock would be the heat generation rate of the waste packages, the linear spacing of the waste packages in the emplacement drifts, and the rate and duration of ventilation after waste package emplacement in the drifts. Operational parameters that DOE could use (independently or in combination) to control repository temperatures (waste package, drift wall, and the overall repository) include (1) varying the waste package *thermal loading* to control the thermal output, (2) varying the duration of the preclosure ventilation period with 15-cubic-meter (530-cubic-foot)-per-second average drift ventilation, and (3) varying the distances between waste packages in the emplacement drifts (DIRS 153849-DOE 2001, Section 2.1.4). The operational parameters would work in combination to control the maximum waste package surface temperature and, thus, the heat transferred to the emplacement drift walls. DOE could use a combination of the three to maximize repository operational efficiency and achieve thermal objectives, as described below.

- *Waste Package Thermal Loading (including surface aging).* Commercial spent nuclear fuel would be the major contributor of heat in the repository. It would have a wide range of thermal outputs. The thermal output of the waste packages could be reduced, however, by varying waste package loading. Waste package thermal loading could be varied by (1) placing low-heat-output (older) fuel with high-heat-output (younger) fuel in the same waste package (fuel *blending*), (2) limiting the number of spent nuclear fuel assemblies to less than the waste package design capacity (derating), (3) using smaller waste packages, or (4) placing younger fuel in a surface aging area to allow its heat output to dissipate so it could meet thermal goals for later emplacement. Section 2.1.2.1.1.2 describes the fuel blending process further. Reducing the thermal output of the waste packages through any of these means would achieve lower waste package and drift wall temperatures. DOE would consider aging as much as two-thirds of the commercial spent nuclear fuel (DIRS 152007-Mattsson 2000, p. 2) during a 50-year period. Aging would require an extended emplacement period.

- *Drift Ventilation Duration.* During repository operations, forced-air (active) or natural (passive) ventilation of the loaded drifts would remove an appreciable part of the heat generated by the waste packages. DOE could reduce the amount of heat delivered to, and thus the maximum temperatures in, the host rock by extending the drift ventilation period with either active or passive ventilation. This could require an extended ventilation period of as long as 300 years after final emplacement to ensure that postclosure temperatures (waste package surface and drift wall) remained below specified goals (DIRS 153849-DOE 2001, Section 2.1.5.2, Table 2-2).

- *Distance Between Waste Packages.* The distance between waste packages in emplacement drifts is another operational variable that DOE could use to manage the thermal response of the repository. With waste packages spaced farther apart, the linear thermal load in each drift would decrease, delivering less heat per unit length of the emplacement drift. Implementing an increase in average waste package spacing would require more emplacement drifts and potentially additional subsurface *infrastructure* than the higher-temperature repository operating mode. Under the lower-temperature repository operating mode, waste package spacing could vary from 0.1 meter (0.33 foot) (DIRS 153849-DOE 2001, Section 2.1.2.2) to 6.4 meters (21 feet) (DIRS 152003-McKenzie 2000, Option 1, p. 2).

These three operational parameters are interrelated; that is, they would work together to achieve the desired result. For example, a combination of 2.1-meter (6.9-foot) waste package spacing, surface aging of commercial spent nuclear fuel, and 125 years of forced-air ventilation (from the start of emplacement) would be adequate to achieve the repository lower-temperature thermal objectives. Another example would be a combination of 2-meter (6.6-foot) waste package spacing, no surface aging, and 75 years of forced-air ventilation (from the start of emplacement) followed by 250 years of *natural ventilation* (DIRS 153849-DOE 2001, Section 2.1.5.2, Table 2-2).

2.1.1.3 National Transportation Scenarios

The national transportation scenarios evaluated in this EIS encompass the transportation options or modes (legal-weight truck and rail) that are practical for DOE to use to ship spent nuclear fuel and high-level radioactive waste from the commercial and DOE sites to the Yucca Mountain site. DOE would use both legal-weight truck and rail transportation, and would determine the number of shipments by either mode as part of future transportation planning efforts. Therefore, the EIS evaluates two national transportation scenarios (mostly legal-weight truck and mostly rail) that cover the possible range of transportation impacts to human health and the environment.

TERMS ASSOCIATED WITH TRANSPORTATION

Legal-weight trucks have a gross vehicle weight (both truck and cargo weight) of less than 36,300 kilograms (80,000 pounds), which is the loaded weight limit for commercial vehicles operated on public highways without special state-issued permits. In addition, the dimensions, axle spacing, and, if applicable, axle loads of these vehicles must be in compliance with Federal and state regulations.

An **intermodal transfer station** is a facility for transferring freight from one transportation mode to another (for example, from railcar to truck). In this EIS, intermodal transfer station refers to a facility DOE would use to transfer rail shipping casks containing spent nuclear fuel or high-level radioactive waste from railcars to heavy-haul trucks, and to transfer empty rail shipping casks from heavy-haul trucks to railcars.

Heavy-haul trucks are overweight, overdimension vehicles that must have permits from state highway authorities to use public highways. In this EIS, heavy-haul trucks refers to vehicles DOE would use on public highways to move spent nuclear fuel or high-level radioactive waste shipping casks designed for a railcar.

2.1.1.4 Nevada Transportation Scenarios and Rail and Intermodal Implementing Alternatives

The transportation of spent nuclear fuel and high-level radioactive waste to the proposed repository would affect the states through which the shipments would travel, including Nevada. However, to highlight the impacts that could occur in Nevada, DOE has chosen to discuss them separately. DOE is looking at three transportation scenarios for Nevada. These scenarios include legal-weight truck and rail, which are the same as the national scenarios but highlight the Nevada portion of the transportation, and heavy-haul truck. The heavy-haul truck scenario includes the construction of an intermodal transfer station with associated highway improvements for heavy-haul trucks in the State. DOE has identified five potential rail corridors leading to Yucca Mountain and three potential intermodal transfer station locations with five associated potential highway routes for heavy-haul trucks. Section 2.1.3.3 describes these implementing alternatives.

2.1.1.5 Continuing Investigation of Design Options

As noted, this EIS describes and evaluates the flexible design concept for the repository and current plans for repository construction, operation and monitoring, and closure (see Section 2.1.2). DOE continues to investigate design options for possible incorporation in the final repository design; Appendix E identifies design features that DOE is considering for the final design (for example, specific design and operational considerations regarding natural ventilation and its duration; consideration of indefinite ventilation period; modular construction of repository facilities; whether to handle commercial spent nuclear fuel using a pool with water or a dry transfer system; and site access road construction). The criteria for selecting these design options are related to improving or reducing uncertainties in repository performance (the potential to provide containment and isolation of radionuclides) and operation (for example, worker and operational safety, ease of operation).

DOE has assessed each of the design options still being considered for the expected change it would have on short- and long-term environmental impacts and has compared these impacts to the potential impacts determined for the packaging, operating mode, and transportation scenarios evaluated in the EIS. This assessment, which is described in Appendix E, found that the changes in environmental impacts for the design options would be relatively minor in relation to the potential impacts evaluated in this EIS. Therefore, DOE has concluded that the analytical scenarios and implementing alternatives evaluated in this EIS provide a representative range of potential environmental impacts the Proposed Action could cause. Chapter 9 discusses mitigation from design options that could be beneficial in reducing impacts associated with repository performance or operation.

2.1.2 REPOSITORY FACILITIES AND OPERATIONS

This section describes proposed repository surface and subsurface facilities and operations (Sections 2.1.2.1 and 2.1.2.2), the performance confirmation program (Section 2.1.2.3), and repository closure (Section 2.1.2.4) . The description is based on the Science and Engineering Report (DIRS 153849-DOE 2001, all) and other engineering data files (DIRS 104508-CRWMS M&O 1999, all; DIRS 104523-CRWMS M&O 1999, all; DIRS 102030-CRWMS M&O 1999, all) unless otherwise noted. The following paragraphs contain an overview of the repository facilities and operations and the sequence of planned repository construction, operation and monitoring, and closure. DOE would design the repository based on the extensive information collected during the Yucca Mountain site characterization activities. These activities are summarized in semiannual site characterization reports. [See the semiannual Site Characterization Progress Reports that the Department prepares in accordance with Section 113(b)(3) of the NWPA (for example, DIRS 155982-DOE 2001, all).] The facilities used for site characterization activities at Yucca Mountain would be incorporated in the repository design to the extent practicable. (See Chapter 3, Section 3.1, for additional information on existing facilities at Yucca Mountain developed during site characterization activities.)

DOE would construct surface facilities at the repository site to receive, prepare, and package spent nuclear fuel and high-level radioactive waste for underground emplacement. In addition, surface